U.S. Department of the Interior
U.S. Geological Survey

Prepared in cooperation with
Chester County Water Resources Authority
Chester County Health Department

Water-Resources Investigations Report WRIR 98-4169
Geology and concentrations of radon-222 Plate 1
Senior, L.A., 1998, Radon-222 in the ground water of
Chester County, Pennsylvania

40° 15'
76° 00'
75° 45'
75° 30'
40° 00'
39° 45'

EXPLANATION

MEDIAN CONCENTRATION OF RADON-222 IN GROUND WATER OF GEOLOGIC UNIT

- LESS THAN 1,000 PICOCURIES PER LITER OR NO DATA AVAILABLE
- GREATER THAN OR EQUAL TO 1,000 PICOCURIES PER LITER BUT LESS THAN 2,000 PICOCURIES PER LITER
- GREATER THAN OR EQUAL TO 2,000 PICOCURIES PER LITER
- GEOLOGIC CONTACT
- MUNICIPAL BOUNDARY
- 1300 WELL AND CONCENTRATION OF RADON-222 IN PICOCURIES PER LITER IN GROUND WATER

UTM GRID AND 1983 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

0 1 2 3 4 5 MILES
0 1 2 3 4 5 KILOMETERS

Base from U.S. Geological Survey Chester County, 1:50,000, 1984

Geology from Sloto, 1994

GEOLOGY AND CONCENTRATION OF RADON-222 IN GROUND-WATER SAMPLES FROM 534 WELLS, CHESTER COUNTY, PENNSYLVANIA, 1986-1996

by Lisa A. Senior

DESCRIPTION OF MAP UNITS

Tpb **Pensauken and Bridgeton Formations, undivided--** Dark-reddish-brown, cross-stratified, feldspathic quartz sand and some thin beds of fine to coarse gravel; layers and lenses of clay or silt are also present. Most of the clasts are pebbles and cobbles, but a few reach boulder size. The matrix is earthy and muddy, imparting a significant compactness to the deposits.

Tbm **Bryn Mawr Formation--** High-level terrace deposits consisting of reddish-brown gravel, "ironstone conglomerate", gravelly loam, sand, and sandy loam, some of which is firmly indurated.

Jrd **clabase--** Dark-gray, fine-grained (in dikes) to medium grained (in plutons) rock consisting mainly of plagioclase and pyroxene.

Trb **Brunswick Group--** Reddish-brown, thin- to medium bedded mudstone, shale, siltstone, and fine-grained sandstone containing a few green and/or brown shale interbeds. Near the base are tongues of thick bedded, red argillite interbedded with dark-gray argillite characteristic of the underlying Lockatong Formation.

Trh **Hammer Creek Formation--** Red to brown and light gray, medium- to thick-bedded, fine- to medium grained sandstone with subordinate siltstone and shale occurring between thick tongues of conglomeratic sandstone.

Trl **Lockatong Formation--** Thick- to very-thick-bedded, medium- to dark-gray argillite interbedded with thin beds of gray to black shale, siltstone, and marlstone.

Trs **Stockton Formation--** Light-gray, fine- to coarse-grained arkosic sandstone in the lower part; reddish brown to grayish-purple, fine-grained sandstone, siltstone, shale, and mudstone in the upper part. The lower part is interlayered with thick beds of conglomeratic sandstone containing pebbles and cobbles of quartz and quartzite.

OCc **Conestoga Limestone--** Blue-gray, thin-bedded, argillaceous limestone with intervals of purer granular limestone containing mica flakes on cleavage and bedding surfaces. Impure part has thin bedded alternations of dark-gray, clayey, silty, micaceous layers and medium-gray, argillaceous limestone. Also contains conglomeratic beds with pebbles and masses of white to gray granular marble in a gray limestone matrix.

Ce **Elbrook Limestone--** Finely-laminated, fine-grained, interbedded dolomite and limestone with muscovite and sericite on bedding and cleavage surfaces.

Cl **Ledger Dolomite--** Light-gray to white, thick-bedded, rather pure, granular dolomite, locally speckled and mottled. Contains a few beds of high-calcium Marble.

Ck **Kinsers Limestone--** Gray micaceous limestone and calcareous mica schist with interbeds of dark-gray shale, dark-gray banded argillaceous limestone, and spotted white to gray marble.

Cv **Vintage Dolomite--** Dark-gray, granular dolomite with wavy, knotted texture. At the base is a white, knotted marble; in the upper part is a light-gray, coarse- to fine-grained, thick-bedded dolomite.

CZah **Antietam and Harpers Formations, undivided--** Gray, thin- to thick-bedded, laminated quartzite, quartzose schist, and sandy micaceous schist.

Zch **Chickies Quartzite--** White to light-gray, thin- to thick bedded quartzite with interbeds of quartzose schist and sandy mica schist. Conglomerate at the base contains white, colorless, and blue quartz pebbles and granules.

Csp **serpentinized ultramafite--** Serpentinized dunite and chromitite, overlain by a transitional interlayered unit of metamorphosed cumulus peridotite, pyroxenite, and gabbro.

Cgb **mettagabbro and gabbro--** Mostly metamorphosed hypersthene gabbro containing numerous cumulus peridotite layers.

pc **Peters Creek Schist--** Generally a green mica schist with interbeds of thin to thick beds of chlorite bearing granular quartzite. The pelitic part is usually a quartz-muscovite-chlorite-orthoclase schist.

oct **Octoraro Phyllite--** Bluish-gray to greenish-gray, well foliated quartz-muscovite-chlorite phyllite with lustrous, smooth laminae; often contains quartz lenses parallel to the laminae around which the foliation wraps. Locally, a purplish slate is present.

wb **Wissahickon Schist--** Light- to medium-gray, quartzo-aluminous schist and gneiss. Composition ranges from quartz-orthoclase-biotite and orthoclase-quartz-muscovite schist to quartz-biotite-plagioclase and quartz-plagioclase-biotite schistose gneiss. Moderately high metamorphic grade, mostly in the amphibolite facies.

ck **Cockeysville Marble--** White, medium- to coarse grained, saccharoidal marble and light-gray, fine grained, banded marble; often containing scattered golden-brown phlogopite flakes.

st **Setters Quartzite--** White to light-gray quartzite, quartzose schist, and potassic-feldspar-quartz-biotite-quartz-orthoclase(?)-muscovite schist.

pg **Pegmatite--** Light colored, very-coarse- to coarse grained dikes and masses of granitic rock, containing mostly alkali feldspars and quartz with subordinate amounts of muscovite or biotite.

um **Ultramafite--** Yellowish-green, grayish-green, dark green, and medium-darkgray masses (up to hundreds of feet in size) of peridotite and pyroxenite, usually altered to serpentine, steatite, talc, actinolite, tremolite, and numerous other accessory minerals. In Mine Ridge, also includes granoblastic hornblendite containing some secondary chlorite.

ma **mafic gneiss, amphibolite facies--** Very-dark-gray, medium- to coarse-grained amphibolite, interlayered with some felsic laminae and layers. Mafic layers consist of hornblende, clinopyroxene, plagioclase, and biotite. Felsic layers and laminae contain plagioclase, quartz, hornblende, orthopyroxene, and biotite.

m **marble** (at Peters Creek-Octoraro contact)-- White to bluish-gray, medium- to coarse-grained, saccharoidal marble, dolomitic in part, with accessory phlogopite.

md **Metadiabase--** Bluish-gray to greenish-gray, fine-grained rock with ophitic texture containing plagioclase (chiefly labradorite) and pyroxene (usually augite).

Ybm **Marble--** White to light-gray, massive, coarsely crystalline marble, dolomitic in part. This single occurrence of marble in the Avondale massif also contains phlogopite, pyrrhotite, diopside, and chondrodite.

Ybma **mafic gneiss, amphibolite facies--** Medium- to dark-gray, medium-grained, finely to coarsely layered plagioclase-hornblende-pyroxene-biotite+/-quartz+/-garnet+/-titanite gneiss. Also present are amphibolitic rock and metadiabase.

Ybfa **felsic and intermediate gneiss, amphibolite facies--** Light- to medium-gray, medium-grained, finely to coarsely layered quartz-plagioclase-biotite-potassium-feldspar-garnet+/-hornblende gneiss.

Ybfg **felsic gneiss, granulite facies--** Rather variable composition: medium- to dark-gray, coarse-grained Plagioclase-quartz-orthoclase-garnet-biotite-hypersthene/clinopyroxene gneiss (strongly lineated) to light-gray, fine- to medium-grained quartz-mesoperthite-garnet+/-biotite+/-hypersthene gneiss. Quartz-kyanite and quartz-garnet+/-kyanite rocks are present locally.

Ybmg **mafic gneiss, granulite facies--** Medium- to dark-gray, medium-grained, granoblastic plagioclase - clinopyroxene-hypersthene-garnet gneiss with or without biotite, quartz, orthoclase, and hornblende as accessory minerals.

Yhfa **felsic gneiss, amphibolite facies--** Massive, slightly foliated quartz-plagioclase-biotite-muscovite-epidote gneiss with trace hornblende and orthoclase. Granular quartz-rich layers alternate and grade into quartz-plagioclase layers. Clots of muscovite flakes parallel scattered biotite layers.

Yhga **graphitic felsic gneiss, amphibolite facies--** Massive, slightly foliated quartz-plagioclase-epidote-graphite gneiss, with minor biotite and muscovite and trace orthoclase. Granular quartz-rich layers alternate and grade into quartz-plagioclase layers. Clots of muscovite flakes parallel scattered biotite layers. Differs from felsic gneiss (Yhfa) solely by the presence of graphite.

Yhia **felsic and intermediate gneiss, amphibolite facies--** Massive, slightly foliated quartz-plagioclase-biotite-muscovite-epidote+/-hornblende gneiss with trace garnet in the biotite rich layers. Granular quartz-rich layers alternate and grade into quartz-plagioclase layers. Clots of muscovite flakes parallel scattered biotite layers.

Yhma **banded mafic gneiss, amphibolite facies--** Alternating layers of quartz-plagioclase-hornblende felsic gneiss with minor muscovite, biotite, and epidote and hornblende-plagioclase-biotite-epidote mafic gneiss with disseminated garnet prophyroblasts.

Yhfg **felsic and intermediate gneiss, granulite facies--** Medium- to coarse-grained quartz-plagioclase mesoperthite felsic gneiss with subordinate hornblende, augite, and hypersthene. Intermediate gneiss contains a somewhat higher proportion of mafic minerals. The felsic gneiss is extensively interlayered with subordinate amounts of the mafic and intermediate gneiss.

Yhgg **graphitic felsic gneiss, granulite facies--** Medium- to coarse-grained quartz-plagioclase-mesoperthite-hypersthene-graphite felsic gneiss with very subordinate amounts of microcline, hornblende, and augite. The graphite occurs as medium-grained rods, irregular patches and stringers, and distinct layers. Extensively interlayered with subordinate amounts of mafic gneiss.

Yhm **Marble--** White to light-gray, massive to banded, coarsely crystalline marble, dolomitic in part. Graphite is present at all localities, and each occurrence is associated with graphitic felsic gneiss.

Yhmg **mafic gneiss, granulite facies--** Medium-grained, equigranular hornblende-plagioclase-quartz+/-augite+/-hypersthene mafic gneiss with subordinate mesoperthite and trace garnet and biotite. Extensively interlayered with the dominant felsic gneiss.

Yhan **anorthosite suite**
anorthosite (40 percent) massive, dark-bluish-gray to light-gray to pinkish-gray, coarse-grained, granular plagioclase with subordinate disseminated and segregated patches of hornblende, biotite, quartz, apatite, and magnetite.
leuco-hornblende gabbro (40 percent) massive, "peppered" dark-bluish-gray to light-gray, coarse grained, granular plagioclase with lesser amounts of disseminated and segregated patches of hornblende, biotite, and magnetite. Transitional between anorthosite and hornblende gabbro; plagioclase is somewhat more sodic than in the anorthosite.
hornblende gabbro (20 percent) massive, light gray to pink, very coarse-grained, very granular plagioclase with numerous lenses and layers of the mafic minerals hornblende, biotite, and garnet.

Ymfa **felsic to mafic gneiss** (Mine Ridge massif)
felsic gneiss--foliated, light-gray, medium-grained quartz-plagioclase-biotite gneiss with minor muscovite, epidote, and garnet. Alternating granoblastic quartzofeldspathic and biotite-rich layers, lepidoplastic micas, and elongated quartz define the foliation. Also present are massive, granoblastic, medium- to coarse-grained potassium bearing pegmatite and muscoviterich pegmatite lacking potassium feldspar.
Intermediate gneiss--foliated, light-gray, medium grained quartz-plagioclase-hornblende gneiss with minor biotite and chlorite and quartz-plagioclase-biotite-chlorite-garnet gneiss. Both types contain quartzofeldspathic and ferromagnesian lenses and bands parallel to the foliation.
mafic gneiss--dark-gray hornblende-biotite-quartz+/-plagioclase+/-clinozoisite gneiss and greenish-gray epidote-chlorite-quartz-titanite gneiss; both occur as massive and unfoliated or as discontinuously banded with alternating layers of ferromagnesian and quartzofeldspathic minerals.
ultramafite--dark-gray, coarse-grained, granoblastic to slightly nematoblastic hornblendite; also dark greenish-gray, fine- to medium-grained, granoblastic to slightly foliated rock of serpentine, chlorite, talc, and altered hornblende.

CORRELATION OF MAP UNITS